インド南部、始生代ダールワール岩体のチトラドゥルガ片岩帯における硫黄同位体研究

山崎里英 [1]、M. Satish-Kumar[1]、上野雄一郎 [2]、外田智千 [3]、A. Nasheeth[4]、中川麻悠子 [2]
[1] *静岡大学*
[2] *東京工業大学*
[3] *国立極地研究所*
[4] *大阪市立大学*

Sulfur isotope study of Chitradurga schist belt, Archean Dharwar craton, India.

R. Yamazaki[1], M. Satish-Kumar[1], Y. Ueno[2], T. Hokada[3], A. Nasheeth[4] and M. Nakagawa[2]
[1]*Shizuoka Univ.*
[2]*Tokyo Tech.*
[3]*NIPR*
[4]*Osaka City Univ.*

Introduction

After the appearance of life on Earth, major global changes of microbial, climate and geology had occurred in Archaean era. Especially, rise of atmospheric oxygen have been reported in the late Archaean to early Proterozoic. Mass independent fractionation of sulfur isotope (MIF; $\delta^{33}S \neq 0.515 \times \delta^{34}S$), which shown in Archaean rock samples but absent in Proterozoic samples is known as one of the evidence of rise of atmosphere oxygen. The MIF-S signatures are thought to have originated from sulfur photochemical reactions in an anoxic atmosphere, and disappear from the rock record during the early Paleoproterozoic due to oxygenation of the atmosphere (Farquhar et al., 2000; Pavlov and Kasting, 2002). However, an exceptionally low S-MIF has been reported in Archean rocks deposited between ~ 2.7Ga and ~ 3.2Ga, and interpreted as primary increase of oxygen concentration (Ohmoto et al., 2006; Frei et al., 2009). Therefore detail study of late Archaean rocks give us new insights into early Earth's atmosphere evolution.

The late Archean (3400-2400Ma) sedimentary to low-grade metasedimentary rocks are exposed in the Chitradurga schist belt, western Dharwar craton. The Chitradurga schist belt consists of >3.0Ga green stones (Sargur Group) and 2.9-2.6Ga volcano-sedimentary sequence(Dharwar Super Group), surrounded by ~3.0Ga TTG (tonalitic-trondhjemitic-granodioritic) gneiss, which is known as "Peninsular gneiss" (Chadwick et al., 2000; Jayananda et al., 2006). Geological field studies in the Chitradurga area was carried out and representative samples of metapelites, banded iron formation, quartzite, greenschists and carbonate from all formations were collected.

Here, we report preliminary results of sulfur isotope geochemistry of sulfide minerals in metasedimentary rocks from the Chitradurga schist belt in the Archaean Dharwar craton, India.

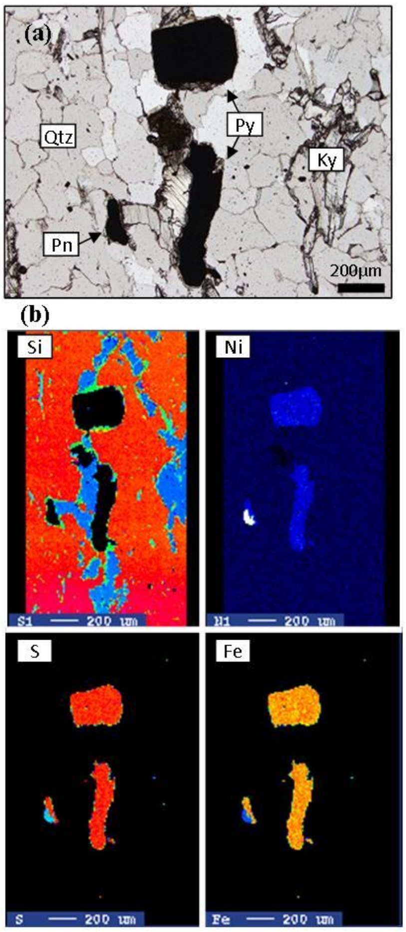

Figure 1. (a) Photomicrograph showing the mode of occurrence of sulfides in quartzite in the plane polarized light. Py; pyrite, Pn; pentlandite Qtz; quartz, Ky; kyanite. (b) Elemental maps show the difference of chemical composition of sulfides clearly. Scales in all figures are 200μm.

Methods

Rock samples were cut, polished and thin sections were prepared. Thin sections were polished using diamond paste for microscopic observation and EPMA analysis. Sulfur isotope ratios (^{32}S/ ^{33}S/ ^{34}S/ ^{36}S) for sulfide were analyzed from selected samples that contain sulfide minerals. The analytical reproducibility of the $\delta^{34}S$, $\Delta^{33}S$ and $\Delta^{36}S$ values based on replicate analyses of IAEA-S1 standard is better than ±0.3‰, ±0.01‰, ±0.7‰.

Results and discussion

Sulfide minerals in quartzite, crystallime limestone (Sargur Group), Peninsular gneiss and mineralized rock (Hiriyur Formation which is a top sequence of Dharwar

Supergroup) were analyzed.

Most of the sulfide minerals are pyrite (FeS_2), but pentlandite ($(Fe, Ni)_9S_8$) and galena (PbS) are also observed slightly(Figure 1).

The $\delta^{34}S$, $\Delta^{33}S$ and $\Delta^{36}S$ vary from -3.4~1.8‰, -0.15~0.09‰ and -0.86~0.32, respectively (Fig. 2). All sample show mass dependent fractionation (MDF; $\Delta^{33}S$=0‰). The plot of $\Delta^{33}S$ vs. $\Delta^{36}S$ doesn't compare with the slope that produced by SO_2 photolysis ($\Delta^{36}S/\Delta^{33}S$ = ~ -1; Farquhar et al., 2000; 2001). However, it is similar to the theoretical predictions for mass dependent process ($\Delta^{36}S/\Delta^{33}S$ = -6.85; Ono et al., 2006). These results indicate that the sulfur could have been derived from magma ($\delta^{34}S$~0‰, $\Delta^{33}S$~0‰), and not via an Archaean anoxic atmosphere. Quartzite samples have relatively low $\delta^{34}S$ and it suggests the possibility of bacterial sulfate reduction.

Further detailed isotopic studies from some sedimentary rock samples such as shale, sand stone and BIF are in progress. In our presentation, we will discuss based on these results.

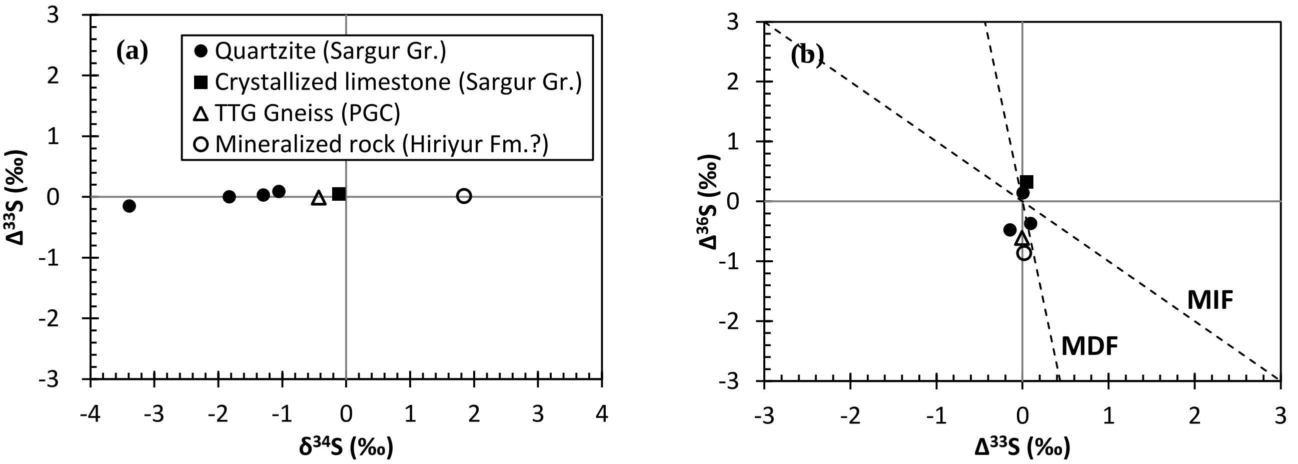

Figure 2. *(a) $\delta^{34}S$ vs. $\Delta^{33}S$ relationship. All samples show MDF. This suggests that the sulfur could have been derived from magma, and not via an Archaean anoxic atmosphere. Low $\delta^{34}S$ from quartzite samples suggests the possibility of bacterial sulfate reduction. (b) $\Delta^{33}S$ vs. $\Delta^{33}S$ relationship. Dashed lines are fractionation lines; slope of MDF is -6.85 (Ono et al., 2006), whereas slope of MIF is ~-1 (Farquhar et al., 2000; 2001). Most samples fall in the array of MDF.*

References

Chadwick, B., Vasudev, V. N. and Hegde, G. V., 2000, The Dharwar craton, southern India, interpreted as the result of Late Archaean oblique convergence, *Precambrian Research*, **99**, 91-111.

Farquhar, J., Bao, H. and Thiemens, M., 2000, Atmospheric Influence of Earth's Earliest Sulfur Cycle, *Science*, **289**, 756-758.

Farquhar, J., Savarino, J., Airieau, S. and Thiemens, M. H., 2001, Observation of wavelength-sensitive mass-independent sulfur isotope effects during SO_2 photolysis: Implications for the early atmosphere. *Journal of Geophysical Research*, **106**, 32829-32839.

Frei, R., Gaucher, C., Poulton, S. W. & Canfield, D. E., 2009, Fluctuations in Precambrian atmospheric oxygenation recorded by chromium isotopes. *Nature*, **461**, 250-253.

Jayananda, M., Chardon, D., Peucat, J.-J. and Capdevila, R., 2006, 2.61 Ga potassic granites and crustal reworking in the western Dharwar craton, southern India: Tectonic, geochronologic and geochemical constraints. *Precambrian Research*, **150**, 1-26.

Ohmoto, H., Watanabe, Y., Ikemi, H., Poulson, S. R. and Taylor, B. E., 2006, Sulphur isotope evidence for an oxic Archean atmosphere. *Nature*, **442**, 908-911.

Ono, S., Wing, B., Johnston, D., Farquhar, J. and Rumble, D., 2006, Mass-dependent fractionation of quadruple stable isotope system as a new tracer of sulfur biogeochemical cycles. *Geochimica et Cosmochimica Acta*, **70**, 2238-2252.

Pavlov, A. A., Kasting, J. F. and Brown, L. L., 2001, UV-shielding of NH_3 and O_2 by organic hazes in the Archean atmosphere. *Journal of Geophysical Research*, **106**, 23267-23287.